

The more complicated spectra which are frequently observed seem referable to the existence of more than two twin planes in close proximity. There is no reason to think that the explanation of these spectra would involve any new principle not already contained in the explanation of the appearance presented when there are only two twin planes, though the necessary formulæ would doubtless be more complicated.

Corresponding to a wave incident in any direction, in one component of a twin, on the twin plane, there are in general two refracted waves in the second component in planes slightly inclined to each other, and two reflected waves which also have their planes slightly inclined to each other, the angle of inclination, however, being by no means *very* small, as chlorate of potash is strongly double refracting. The planes of polarisation of the two refracted waves are approximately perpendicular to each other, as are also those of the two reflected waves; but on account of the different orientation of the two components of the twin, the planes of polarisation of the two refracted waves are in general altogether different from those of the incident wave and of its fellow, the trace of which on the twin plane would travel with the same velocity. In the plane of symmetry at any incidence, and for a small angle of incidence at any azimuth of the plane of incidence, the directions of the planes of polarisation of the two refracted waves agree accurately or nearly with those of the incident wave and its fellow. In these cases, therefore, an incident wave would produce hardly more than one refracted wave, namely, that one which nearly agrees with the incident wave in direction of polarisation. In these cases the colours are not produced. It appears, therefore, that their production demands that the incident wave shall be very determinately divided into two refracted waves, accompanied of course by reflected waves.

It seems evident that the thickness of the stratum affects the result through the difference of phase which it entails in the two refracted waves on arriving at the second twin plane. But whereas in the ordinary case of the production of colour by the interposition of a crystalline plate between a polariser and an analyser, we are concerned only with the difference of retardation of the differently polarised pencils which are transmitted across the plate, and not with the absolute retardation, it is possible that in this case we must take into account not only the difference of retardation for the differently polarised pencils which traverse the stratum, but also the absolute retardation; that is, the retardation of the light reflected from the second relatively to that reflected from the first twin plane.

21. I have not up to the present seen my way to going further. It is certainly very extraordinary and paradoxical that light should suffer total or all but total reflection at a transparent stratum of the very same substance, merely differing in orientation, in which the light had been travelling, and that, independently of its polarisation. It can have nothing to do with ordinary total internal reflection, since it is observed at quite moderate incidences, and *only within very narrow limits* of the angle of incidence.

RECENT PROGRESS IN CHEMISTRY¹

THE progress of chemistry during the last year has been considerable, and a great deal of interesting and important work has been done. Nevertheless it cannot be said to have been a year productive of any very special discoveries. In physical chemistry the subjects connected with heat have occupied a good deal of attention, such as the heat of formation of chemical compounds, &c. Experiments on the liquefaction and solidification of gases by pressure and low temperature have also been continued, and, in addition to the results which were obtained some time since, we now know chlorine, not only as a liquid, but also as a crystalline solid. The same is true of hydrochloric acid, carbonic oxide, silicon fluoride, and assinuretted hydrogen.

Last year I referred to the work which was being done with hydroxylamine, and also mentioned that another analytical reagent of equal importance was claiming attention, viz. Emil Fischer's phenylhydrazine. The promise of new work which this substance gave has been fully realised, and it has proved useful, not only as an analytical reagent, but has been the means of producing a number of new and important products.

Work is still actively pursued on the pyrroline, pyridine, and

quinoline series, and it is remarkable to see how new methods for the production of bodies of this description are being constantly discovered. Those of A. Behrmann and Hofmann, who obtain pyridine derivatives from citramide, and of H. v. Pechmann, who obtains them from malic acid, may be taken as illustrations.

It is interesting to notice, in reference to the pyridine series, Ladenburg's experiments (*Ber.*, xvii. 772-74), who finds that the compounds formed by the union of these bases with the iodides of the alcohol radicals, when strongly heated, yield substituted pyridines in the same way as Hofmann showed some time since that aniline, under like circumstances, yielded substituted anilines, such as toluidine, &c. Hofmann (*Ber.*, xvii. 1200) has also found that conine hydrochloride, when distilled with zinc dust, yields a base he has named conyrine, which he believes to be a propyl or isopropyl pyridine; and this, by treatment with hydriodic acid at 280°-300°, regenerates conine, which has exactly the same physiological action as the natural (though it is probably optically inactive). Ladenburg (*Ber.*, xvii. 1196) has obtained a propylpyridine which, when treated with sodium and alcohol, yields a base smelling very much like conine; it has many properties in common with conine, and, like it, is poisonous, acting in the same manner and to the same degree. It is, however, optically inactive, as might be expected. It will be remembered that Schiff (*Ann. Ch. Pharm.*, clvii. 352) obtained a base very similar to conine from isobutyric aldehyde and ammonia some years ago, but it did not appear to agree in all its properties with that body. From the new work which has been done in this subject we may now soon expect to have the constitution of this base definitely established. Ladenburg has also succeeded in producing piperidine from pyridine. The identity of this product with that obtained from piperine from pepper has been established (*Ber.*, xvii. 513-515).

Hofmann, while continuing his work on the action of bromine in alkaline solutions in amides, has found the curious fact that nitriles are produced in considerable quantities containing one atom of carbon less than the amide—in fact, corresponding with the amines formed in the reaction, and are, in all probability, produced from them by the removal of the hydrogen atoms. As these nitriles can be converted into amides by sulphuric acid, and again treated with bromine and alkali, it is evident that by this means we can gradually work down step by step from one member of the homologous series to another.

It will be remembered that Pechmann and Duisberg (*Ber.*, xvi. 2119-2128) succeeded in obtaining substituted coumarins and their hydroxy derivatives by acting on aceto and benzoyl-acetic acids with phenols. Pechmann (*Ber.*, xvii. 929-936) has now succeeded in obtaining coumarins by treating malic acid and phenols with sulphuric acid or chloride of zinc; with ordinary phenol he has obtained coumarin; with resorcinol, umbelliferone and with pyragallol, daphnetin, which gives all the reactions of the natural body.

Some very curious results have lately been obtained in reference to the destructive action of aluminium chloride on hydrocarbons. Friedel and Crafts communicated a paper on this subject to this Society in 1882; it has now been further studied by Auschütz, Immerdorff, and by Jacobson (*Ber.*, xviii. 657). They have found that this action consists in "a transference of the alcohol radical from one molecule of a hydrocarbon to another molecule of the same hydrocarbon." Thus toluene yields, on the one hand, benzene, and on the other, xylene and more highly methylated benzenes, orthoderivatives being very rarely found among the products.

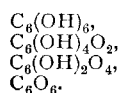
Last year I referred to the discovery of thiophene, or, more properly, thiophen, and its homologues by Victor Meyer. During the year our knowledge of this interesting body has been considerably extended, and its preparation rendered comparatively easy. H. E. Schulze (*Ber.*, xviii. 497) has recently shown that it is contained—as might be expected—in the sulphuric acid used to purify crude benzene, and that if its decomposition be prevented by diluting the acid with an equal bulk of water as soon as it is separated from the benzene, the thiophen which is doubtless present in the form of a sulpho acid may easily be recovered by hydrolysing, by merely passing steam into the acid liquid.

The synthesis of thiophen, recently effected by J. Volhard and H. Erdmann (*Ber.*, xviii. 454) by merely distilling sodium succinate with phosphorus trisulphide (by which about 50 per cent. of the theoretical yield is obtained), is also of interest, as well as the production of methylthiophen from sodium pyro-

¹ From the Annual Address of the President of the Chemical Society, Mr. W. H. Perkin, F.R.S., March 30, 1885.

tartrate by the same reagent. The methylthiophen, however, appears to be isomeric with that separated from coal-tar toluene by Victor Meyer. According to Volhard and Erdmann, thiophen, when cooled in a mixture of carbon dioxide and ether, crystallises like benzene. Paal's synthesis of methyl-phenylthiophen from aceto-phenone-acetone, and of thiophen-carboxylic acid—which is easily resolved into carbon-dioxide and thiophen—from mucic acid, may also be referred to here.

One of the most interesting of recent researches is that of R. Nietzki and T. Benckser on hexhydroxybenzene ($C_6H_6O_6$) (*Ber.*, xviii. 499), which they have succeeded in obtaining from nitranilic (dinitrodehydroxyquinone). They find the diimido body obtained from this when treated with nitric acid, yields a product of the composition $C_6H_{16}O_{14}$, which when treated with reducing agents, yields this substance. They also find that when heated with concentrated nitric acid, hexhydroxybenzene is converted into a body having the remarkable formula $C_6H_{16}O_{14}$. This decomposes when heated to 100° , or when boiled with water, carbon dioxide being given off, and on adding potash solution to the residue or the boiled solution, orange yellow needles of a potassium salt of the formula $C_6K_2O_3$ are obtained, which they have identified as potassium croconate, and they believe that the bodies obtained by Lerch (*Am. Chem. Pharm.*, cxiv. 20) from the compounds of potassium carbonic oxide (formed during the preparation of the metal) were hexhydroxybenzene, tetrahydroxyquinone, and the compound $C_6H_{16}O_{14}$, and in fact that the compound $C_6(OK)_6$ is present in "potassium carbonic oxide." From experiments on the remarkable substance $C_6H_{16}O_{14}$, they came to the conclusion that it is a compound of $C_6O_6 + 8H_2O$, and is a quinone which they call triquinoylbenzene. This appears to be confirmed by the production of the intermediate hydroxy compounds, the following being the series of products:—



In reference to agricultural chemistry Messrs. Lawes and Gilbert have contributed a most important and interesting paper to our Society (1884, pp. 305-407) on the ash of wheat-grain and wheat-straw. They gave the analyses of no less than ninety-two wheat-grain and wheat-straw ashes, every ash being of produce of known history of growth as to soil, season, and manuring, all the specimens having been grown at Rothamstead. Out of the many important deductions this paper contains, the following are extremely interesting:—It appears, in reference to the grain, that on the whole there is great uniformity in its mineral composition under different conditions of manuring, provided only it is perfectly and normally ripened. The influence of season producing a much wider range in the mineral constituents of the grain than the manuring. This, however, is not the case with the straw, as it is found that the amount of mineral ash constituents found in the straw, and therefore in the total crop, have a very direct connection with the amounts available in the soil, but the amounts stored up in the grain itself are little influenced by the quantity taken up.

Besides the researches just referred to there has been a considerable amount of good work done, but it would be out of place for me to refer to it more fully in this short review.

Last year I took occasion to refer to the comparatively small amount of original work which was being prosecuted in this country, notwithstanding the increased number of laboratories and the greater facilities which existed for the encouragement of research. It will be seen from the list of papers that the number brought before the Society during the past year has not increased, but if the papers themselves are examined I think we shall find that the amount of work done is somewhat larger, though certainly not so large as it should be; and it is to be hoped that the spirit of research will be stimulated in the laboratories of the kingdom, and that men may be turned out who are not only more or less analysts, but thorough chemists. Let us not be contented with looking back with pride to what our ancestors have done, but let us follow their example.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, January 15, No. 2, 1885.—Determination of Verdet's constants in absolute units (2 figures), by Prof. Leo Arons.—On the formation of ozone hydrogen per-

oxide and peroxide of sulphur (S_2O_7) by the electrolysis of dilute sulphuric acid (2 figures), by Franz Richarz.—Reply to some statements by F. Kohlrausch, by H. Wild.—On the method of damping for determining the ohm, by Lord Rayleigh.—On the determination of specific heats and melting points at high temperatures (11 figures and 6 tables).—Inaugural address, by Otto Ehrhardt.—Two new methods of finding the angle of polarization of metals, by H. Knoblauch (tables).—The determination of the specific heat of uranium, by Ad. Blüncke.—Experimental research on laws of the emission of light from glowing bodies (5 figures and 7 tables), by W. Möller.—Remarks on J. Fröhlich's treatise, "Kritisches zur Theorie des gebeugten Lichts," by M. Réthy.—Observations on fluorescence, by E. Lommel.—On the double acetates of uranium (9 figures), by C. Rammelsberg.—Note on Kundt's dust figures (2 figures), by H. J. Oosting.

Journal de Physique Théorique et Appliquée, February.—Observations upon the corona now visible around the sun, by M. A. Cornu.—Researches on the combustion of gaseous explosive mixtures, with figures and tables, by MM. Mallard and Le Chatelier.—A new telegraphic system, by M. Estienne.—An experiment in hydrodynamics, by M. P. Parize.—A magneto-electric phenomenon, by C. V. Boys.—A new interference phenomenon produced by sheets of glass with parallel surfaces, and on a method of verifying the parallelism of the surfaces of these sheets, by O. Lummer.—Influence of change of condition from the liquid to the solid state on vapour-pressure, by W. Ramsay and Sydney Young.—Non-sparking key, by W. E. Ayrton and John Perry.—A new arrangement for measuring work, by C. F. Brackett.—Coloured dust particles, by H. H. Hagen.—The horizontal motion of small floating bodies, and the truth of the postulates of the theory of capillarity, by J. Leconte.—Method of registering the free vibrations of a tuning-fork, and the beats, by A. G. Compton.—The expression of electrical resistance as the function of velocity, by F. E. Nipher.—Contributions to meteorology: the reduction of barometric observations to the sea-level, by E. Loomis.—The influence of light on the electrical resistance of metals, by A. E. Bostwick.—On atmospheric absorption, by S. P. Langley.—On the absorption of radiant heat by carbonic acid gas, by J. E. Veller.—The duration of luminous impressions on the retina, by E. L. Nichols.—The relation between the electromotive force of a Daniel cell and the strength of the solution of zinc sulphate, by H. S. Cattzart.

The Journal of the Franklin Institute, No. 710, February, 1885.—Electro-metallurgy, by Nathaniel S. Keith. A lecture delivered at the International Electrical Exhibition of the Franklin Institute, Tuesday, September 23, 1884.—The diving rod, by Rossiter W. Raymond, Ph.D. Conclusion of a lecture delivered at the International Electrical Exhibition, September 18, 1884.—Glimpses of the International Electrical Exhibition, by Prof. Edwin J. Houston. No. 5, Edison's telephonic inventions. Annual summary of engineering and industrial progress, 1884.—Report of the Franklin Institute; items; Japanese colony in Germany; spontaneous decomposition of explosive gelatine; a new refractory brick; globular lightning; solar phenomena in Switzerland; supplement; International Electrical Exhibition report on underground wires. The following systems are described: the American Sectional Underground Company; the Anderson conduit for underground wires; the Brook's underground conduit; the Continental Underground Cable Company; the Cosmopolitan Underground Telegraph, Telephone, and Electric Light Company of New Jersey; the Electric Tube Company; the National Underground Company of New Jersey; Henley's conduit for underground lines; Magner's underground conduit; Philadelphia and Seaboard Telegraph and Cable Company (Pennock's); the Union Electric Underground Company of Chicago; Woodward's curb conduit; the Delany Cable.

Rivista Scientifico-Industriale, February 15-28.—Description of a new galvanometer, with illustration, by Aurelio Mauri.—Experimental researches on earth-currents and those of absorption, by Prof. Antonio Racchetti.—Variations in the electric resistance of solid and pure metallic wires, according to the temperature (continued), by Prof. Angelo Emo.—On an improved method of preserving butterflies' wings, by P. Milani and A. Garbini.

Rendiconti del R. Istituto Lombardo, February 26.—Report on soundings taken in lakes Orta and Idro, Lombardy, for the purpose of determining their mean depths, by Prof. Pietro Pavesi.